CRYSTALLINE SILICATES IN COMET 81P/WILD 2 FROM THE STARDUST TRACK 81.

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Introduction: Previous studies of Stardust samples collected from comet 81P/Wild 2 have reported abundant crystalline phases, presumably formed in the Asteroid belt [1, 2]. In this study, we describe the mineralogical composition of one ultramicrotome section from track 81 (C2092.7.81.1.10) examined by Transmission Electron Microscopy (TEM).

Results and discussion: The microtome section is a polycrystalline aggregate dominated by pyroxenes and plagioclase feldspar. Due to chattering from the microtome sample preparation, it is not possible to determine the exact grain size of the individual phases, but we estimate that the grains are typically submicron to micron in size. We identified low-Ca and Ca-rich pyroxenes (N=12, $En_{80-95}Wo_{1-8}$; N=5, $En_{52-63}Wo_{32-38}$), plagioclase (N=21, $An_{45-85}Ab_{13-55}Or_{0-2}$) and rare, nanometric sulfides. No olivines were found. Low-Ca pyroxenes are enriched in Cr_2O_3 (up to 1.8 wt%; avg. 1.1 wt%), MnO (up to 2.4 wt%; avg. 1.3 wt%) and also contain significant Al_2O_3 (up to 3.8 wt%; avg. 2.6 wt%). Ca-rich pyroxenes contain lower amounts of Cr_2O_3 (up to 0.9 wt%, avg. 0.5 wt%) and MnO (up to 0.8 wt%, avg. 0.6 wt%) but have TiO_2 contents up to 1.3 wt% (avg. 1.1 wt%). The low-Ca pyroxene compositions are extremely unusual having Mn/Fe ratios up to 70x CI, higher that the value of olivines measured previously in Stardust samples [2] (Mn/Fe ratios up to 50x CI). Low-Ca pyroxene Cr_2O_3 and MnO contents correlate positively with Al_2O_3, a relationship that is also observed in low-iron, manganese-enriched (LIME) minerals from interplanetary dust particles (IDP) [3]. The LIME silicates have generally been interpreted as condensates from a gas of solar composition [3]. The compositions of Ca-rich pyroxenes in this particle are also distinct from those found in Kool grains from other Stardust particles [1]. The Al_2O_3 and TiO_2 contents are higher and CaO and Cr_2O_3 lower in the Ca-rich pyroxenes analyzed in this study. However, the average concentrations of Na_2O (2.1 wt%) and MnO (avg. 0.5 wt%) are comparable in both studies.

Although the assemblage enstatite, clinopyroxene and plagioclase feldspar does occur in some plagioclase-bearing chondrules in carbonaceous chondrites [4], the fine-grained character, textural relationships and unusual compositions of the pyroxenes make this particle quite distinct from any known chondritic material. The ambiguous textural relationships between the different phases due to microtoming also prevent any definitive statement about whether the particle is igneous in origin. However, the compositions of the pyroxenes in this particle share similarities to terrestrial igneous pyroxenes that accept Al^{3+} into the tetrahedral sites, creating a charge imbalance that requires the simultaneous entry of Cr^{3+}, Ti^{4+} or Fe^{3+} in the octahedral sites [5]. Irrespective of the exact formation mechanism of this particle, it is clear that the pyroxene mineral chemistry is indicative of another unique type of material in comet 81P/Wild 2 that has not been sampled by any known primitive meteorite, but was present within the feeding zone for the accretion of the Jupiter Family comets.

References: [1] Joswiak D.J., et al. 2009 Meteorit. Planet. Sci. 44, 1561-1588. [2] Brownlee D.E. et al. 2009 Cosmic Dust, 157. [3] Klöck W. et al. 1989 Nature, 339. [4] Scott E.R.D & Krot A.N. 2005 Meteorites, Comets and Planets, Oxford. [5] Campbell I.H. & Borley G.D. 1974 Contrib. Mineral. Petrol. 47, 281-297.